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Fabrication and Charecterization of Multilayer GFRP Composites with Different Orientations

MOHAMMED KETAB YOUSIF
B.Tech Students, Department of Mechanical Engineering, Acharya Nagarjuna University

R.VIJAYA PRAKASH
Assistant Professor, Department of Mechanical Engineering, Acharya Nagarjuna University

Abstract: **Composites are efficient to deal with tensile and compression loads than metals. Now a day, metals are replaced with composites owing to their high strength to weight ratio and are extensively used in aircrafts and automobile structures. These structures are subjected to high strain rates during impact loading, and are crucial in the design of robust composite structures. In the present work Tensile, Compression, Impact and Brinell hardness, for different configurations were obtained. The Tensile, Compression and Hardness were obtained in all the three orientations with the thickness of 1.27cm, where as Compression strength for all the three orientations was obtained with the specimen thickness of 3 cm. All the configurations chosen were as per ASTM standards. Hand lay-up method was used for the production of GFRP composites. The Results of this study indicates that using GFRP in the form of woven structure with Bi-direction orientation improves the mechanical properties compared with Multi and Uni-directional GFRP composites.**

Keywords: **GFRP Composites, Tensile Strength, Flexural Strength.**

I. INTRODUCTION

Glass fiber reinforced composites results in a gorgeous combination of physical and mechanical properties which cannot be obtained by colossal materials [1, 2]. These are widely used due to ease of accessibility of glass fibers and monetary processing techniques adopted for production of components. Developments are tranquil under way to alter their properties for extreme loading conditions. One way to improve the strength of the FRP composites is to add various filler materials. These filler materials act as additional reinforcing components and improve their mechanical properties. The properties of these composites depend on the type and size of the filler material used [3, 4]. Addition of silicon carbide, alumina, and titanium carbide improves hardness, strength and wear resistance of the composites [5, 6]. Graphite particles improved erosive wear resistance of glass fiber epoxy composites [7]. Interest in reinforcing fly ash to GFRP composites is mainly due to, low coefficient of thermal expansion, low density and high strength obtained in these composites. The addition of ceramic particles to the polyether rather ketone composites increased the tensile strength, tensile modulus and flexural modulus [8]. The addition of ceramics to epoxy resin composites increased the compressive strength [9]. The addition of ceramics as filler material in glass vinyl ester composite increased its wear resistance [10]. The impact strength of the epoxy laminated bamboo composite increased with addition of cenosphere as a filler material [11]. The addition of coal ash to glass fiber polymer matrix composites improved their mechanical strength [12].

II. EXPERIMENTATION

Materials

The matrix material used for fabrication of the composites is Epoxy resin (L12 grade) and corresponding hardener (ARADUR R FLY 9511N) is used. E-glass fiber is used as the reinforcing material.

Fabrication and Testing of Composites

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mold surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mold plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats is cut as per the mold size and placed at the surface of mold after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardner (curing agent) and poured onto the surface of mat already placed in the mold. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat- polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at some specific temperature, mold is opened and the developed composite part is taken out and further processed. The schematic of hand lay-up is shown in figure 1. The time of curing depends on type of polymer used for composite processing. For example, for epoxy based system, normal curing time at room temperature is 24-48 hours. This method is mainly suitable for thermosetting polymer based composites. Capital and infrastructural requirement is less as compared to other methods. Production rate is less and high volume fraction of reinforcement is difficult to achieve in the processed composites. Hand lay-up method finds application in many areas like aircraft components, automotive parts, boat hulls, diase board, deck etc. Generally, the materials used to develop composites through hand lay-up method are given in table1.

Figure 1: Mould for preparation of composite specimen

Figure 2: GFRP plates after fabrication

TENSILE TEST (ASTMD3039):

Various m/c and structure components are subjected to tensile loading in numerous applications. For safe design of these components, their ultimate tensile strength and ductility one to be determine before actual use. Tensile test can be conducted on UTM. A material when subjected to a tensile load resists the applied load by developing internal resisting force. These resistances come due to atomic bonding between atoms of the material. The resisting force for unit normal cross-section area is known asstress.

The value of stress in material goes on increasing with an increase in applied tensile load, but it has a certain maximum (finite) limit too. The minimum stress, at which a material fails, is called ultimate tensile strength. The end of elastic limit is indicated by the yield point (load). This can be seen during experiment as explained later in procedure with increase in loading beyond elastic limit original cross-section area (Ao) goes on decreasing and finally reduces to its minimum value when the specimenbreaks.

Figure 3: Tensile test specimen before fracture

Figure 4: Tensile test specimen after fracture

COMPRESSION TEST:

Figure 5 Specimen before and after testing of Compression testing

IZOD IMPACT TEST:

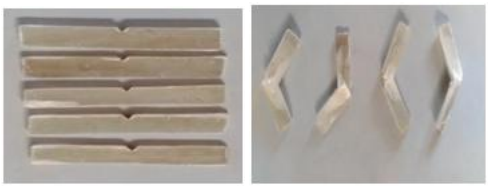

Figure 6.Specimen before and after testing ofIzod impact Testing

III. RESULTS AND DISCUSSIONS

From the fabricated composites, the test specimens are prepared as per ASTM standards and are tested to evaluate their tensile and flexural strength. The results obtained by conducting these tests are given below.

Compression Strength

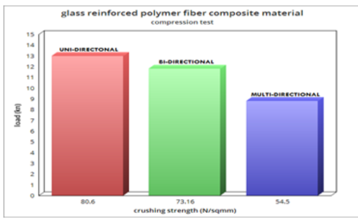

Figure 7: Compression strength of composites

TensileStrength

The effect of fibre content on the tensile strength of the composite is shown in figure 8. It is observed that the tensile strength varies from 346MPa to 501MPa. The tensile strength increases with the bi-directional fiber orientation. The increase in tensile strength with the bi-directional fibre orientation can be attributed to the good interfacial bonding between the glass fibre and the matrix.

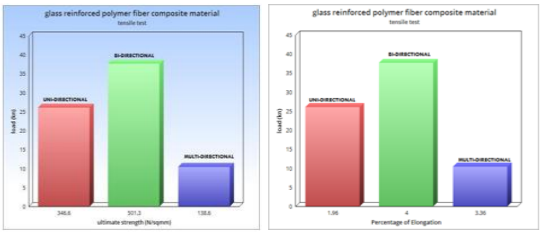

Figure 8: Tensile strength and % of elongation of composites

Hardness and IZOD tests

The effect of glass fibre content on the Hardness of the composite is shown in figure 9 it is observed that the Hardness is improved for unidirectional composite when compared to multi directional.al fiber orientation

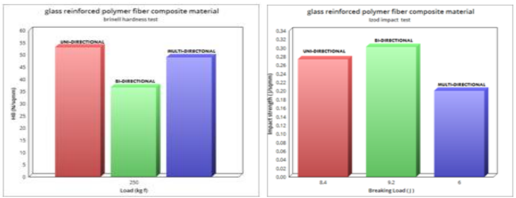

Figure 9: Hardness and IZOD tests of composites

IV. CONCLUSIONS

The experimental investigation on tensile and flexural behaviour of glass fibre reinforced epoxy composites with different orientations have been carried out. The conclusions drawn from the present work are.

In all testing of mechanical properties of materials as Compression, Tensile, Hardness and impact strength on samples of uni-directional, bi-directional and multi-directional glass fiber reinforced epoxy resin based polymer composites, following points have been concluded.

1. .Bi-directional oriented glass fiber reinforced epoxy composites have large value of all the properties such as Ultimate force, Compressive strength, Tensile strength, Elongation, Hardness, Impact strength etc. In tensile as well as impact test it means bi-directional glass fiber composites have more strength than other fiber composites.

2. The comparison between result of both the Tables 1&2 shows that the value of ultimate force in Tensile test in case of Uni-direction, Bi-direction fiber composites.

3. It means that the Uni-directional fiber is greater than bi-directional fiber in hardness and compression test. The Bi-directional fibers are greater than Uni-directional fibers in tensile and impacttest.

V. REFERENCES

[1]. B. Kotiveerachari, A. Chennakesava Reddy, Interfacial effect on the fracture mechanism in GFRP composites, CEMILAC Conference, Ministry of Defence, India, 20-21stAugust 1999:,B85-87.

[2]. A. Chennakesava Reddy, M. VidyaSagar, Two-dimensional theoretical modeling of anisotropic wear in carbon/epoxy FRP composites: comparison with experimental data, International Journal of Theoretical and Applied Mechanics, 2010:6(1),pp.47-57.

[3]. R.Sateesh Raja, K.Manisekar, and V.Manikandan, Effect of fly ash filler size on mechanical properties of polymer matrix composites, International Journal of Mining, Metallurgy and Mechanical Engineering, 2013:(1-1),pp.34-37.

[4]. K.Devendra, and T.Rangaswamy, Strength characterization of E-glass fiber reinforced epoxy composites with filler materials, Journal of Minerals, Material Characterization and Engineering, 2013:(1),pp.353-357.

[5]. Amar Patnaik and S.S Mahapatra, Study on mechanical and erosion wear behavior of hybrid composites using taguchi experimental design, Journal of Materials and Design, 2009:(30),pp.2791-2801.

[6]. S.Chauhan, A.Kumar, A.Patnaik, A.Satapathy and I.Singh, Mechanical and wear characterization of GF reinforced vinyl ester resin composites with different comonomers, Journal of Reinforced Plastic Composites, 2009: (28), pp.2675-2684.

[7]. T. Basava and A.N.Harirao, Development of graphite particles filled epoxy resin composite material and its erosive wear behavior, Interantional Journal on Manufacturing and Material Science, 2011 :(1-2), pp.28-30.

[8]. M. RahailParvaiz, SmitaMohanty, Sanjay K. Nayak and P. A. Mahanwar, Polyetheretherketone (PEEK) composites reinforced with fly ash and mica, Journal of Minerals Materials Characterization and Engineering, 2010: (9-1),pp.25-41.

[9]. ManojSingla , VikasChawla, Mechanical properties of epoxy resin – fly ash composite, Journal of Minerals Materials Characterization and Engineering, 2010: (9-3),pp.199-210.

[10]. S.R. Chauhan, Anoop Kumar , I. Singh , and

Prashant Kumar, Effect of fly ash content on friction and dry sliding wear behavior of glass fiber reinforced polymer composites - A taguchi approach, Journal of Minerals Materials Characterization and Engineering, 2010: (9-4),pp.365-387.

[11]. Hemalata Jena, Mihir Ku. Pandit, and Arun Ku. Pradhan, Study the impact property of laminated bamboo-fibre composite filled with cenosphere, International Journal of Environmental Science and Development, 2012: (3-5),pp.456-459.

[12]. K. Naresh Kumar, M. Prasanth Kumar, V. Krishna, and D. SrinivasaRao, Experimental investigation on mechanical properties of coal ash reinforced glass fiber polymer matrix composites, International Journal of Emerging Technology and Advanced Engineering, 2013: (3- 8), pp.250-258.

[13]. K Praveen Kumar, M Gopi Krishna, J BabuRao, and NRMR Bhargava "Fabrication and Characterization of 2024 Aluminum - High Entropy Alloy Composites", Journal of Alloys and Compounds, 640 (2015) 421–427.

[14]. M Gopi Krishna, K. Praveen Kumar, J. BabuRao& NRMR Bhargava, 'Studies on Deformation Behavior of A356/Al-20Cu-10Mg Particulate Composite Metallic Materials' International Journal of Engineering Research & Technology, vol. 1 Issue 10, 2012, pp 1-6.

[15]. M.Harika, G.Rajeswara Rao, M Gopi Krishna, "Design Modelling And Finite Element Analysis of Double Helical Gearing System For High Speed Compressor Engines" (IJITR) international journal of innovative technology and research Volume No.4, Issue No.6, October – November 2016, 5051-5054.

